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The Role of Deep Ocean Circulation in establishing the Mid-Brunhes Transition

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The Mid-Brunhes Transition (MBT, ~430 ka) marks a fundamental shift in Earth's climate system, characterized by a ~40 ppmv stepwise increase in interglacial atmospheric CO_2 concentrations. This transition occurred during an interval of low eccentricity and precession, which is not unique when considering orbital configurations over the last 800 kyr. Therefore, the MBT marks a change in climate state and has been suggested to result from internal climate system feedbacks. Diminished interglacial Antarctic Bottom Water (AABW) formation and the subsequent contraction of the deep carbon reservoir in the Southern Ocean (SO) are often invoked to explain changes across the MBT.

This study presents a high-resolution (one sample per 3 kyr) hydrogenous (i.e., representing seawater) Nd isotope (expressed as ε_{Nd}) time series from IODP Site U1540 (55°8.5′S, 114°51′W; water depth 3580 m) in the central South Pacific. Given the location of Site U1540, we interpret hydrogenous ε_{Nd} to reflect mixing proportions of Pacific Deep Water, North Atlantic Deep Water (NADW), and Antarctic Bottom Water (AABW). Hydrogenous ε_{Nd} values at Site U1540 oscillate between −8.99 and −5.32, with higher (radiogenic) ε_{Nd} values during glacial periods and lower (unradiogenic) values during interglacials. While no step change in ε_{Nd} is observed across the MBT, the mean glacial ε_{Nd} values before and after the MBT are statistically distinct (p = 0.016). Results from modeling the watermass mixing proportions reveal no significant change in interglacial mean AABW proportion across the MBT; instead, we find that the mean interglacial NADW proportion was significantly lower (p = 0.04) after the MBT. We hypothesize that reduced interglacial NADW contribution to the deep South Pacific after the MBT decreased the density contrast between water masses, thereby weakening deep stratification. Weaker deep stratification after the MBT facilitated the release of stored carbon in the glacial deep ocean, potentially explaining the higher interglacial CO_2 concentrations observed after the MBT.